AMENDMENTS TO THE CLAIMS

1. (withdrawn) An optical pickup comprising:

a first light source that emits a first light beam of a first wavelength $\lambda 1$;

a second light source that emits a second light beam of a second wavelength $\lambda 2$ longer than the first wavelength $\lambda 1$;

an objective lens that focuses the first light beam on an information recording face of a first recording medium having a first light transmissive layer, and focuses the second light beam on an information recording face of a second recording medium having a second light transmissive layer thicker than the first light transmissive layer;

a diffraction optical element disposed in an optical path between the first and second light sources and the objective lens, and including a diffraction grating and a lens with a refractive index n; and

a collimator lens, provided between the first light source and the diffraction optical element and between the second light source and the diffraction optical element, for causing the respective first and second light beams of the first and second light sources to be incident on the diffraction optical element as parallel rays,

wherein:

when a distance between a diffracting face of the diffraction grating and a peak of a lens face of the lens is a, a radius of the second light beam is R, and a pitch of the diffraction grating confined by outermost rays of the second light beam passing through the diffracting grating is d,

said diffraction optical element is set so that m1 and m2, which are diffraction orders of the first and second light beams, respectively, satisfy

$f(\mathrm{d}, m_1) = f(\mathrm{d}, m_2)$,

where f(d, m_x), x being 1 or 2, is a function given by

$$f(d, m_X) = \frac{(R - a \tan\alpha_X)\sqrt{C_X^{\ 2} + S_X^{\ 2}}}{S_X - C_X \tan\alpha_X - \sqrt{C_X^{\ 2} - S_X^{\ 2}} \tan\alpha_X}$$

$$C_X = n\cos\alpha_X - \cos\beta_X$$

$$S_X = n\sin\alpha_X - \sin\beta_X$$

$$\sin\alpha_X = \frac{m_X \lambda_X}{d},$$

where α1 is an diffraction angle for m1-th order diffracted light for the first light beam through the diffraction grating, β1 is an angle made by a refracted ray of the m1-th order diffracted light through the lens with respect to an optical axis of the first light beam, α2 is an diffraction angle for m2-th order diffracted light for the second light beam through the diffraction grating, β2 is an angle made by a refracted ray of the m2-th order diffracted light through the lens with respect to the optical axis.

2. (withdrawn) The optical pickup as set forth in claim 1, wherein the diffraction grating and the lens of the diffraction optical element are provided as an integral unit.

3. (withdrawn) The optical pickup as set forth in claim 1, wherein β1 = 0, and β2 > 0.

4. (withdrawn) The optical pickup as set forth in claim 1, wherein a diffraction order of the m2-th order diffracted light is equal to or lower than a diffraction order of the m1-th order diffracted light.

5. (withdrawn) The optical pickup as set forth in claim 1, wherein the diffraction optical element is set so that m1 = 1, and m2 = 1.

6. (withdrawn) The optical pickup as set forth in claim 1, wherein the diffraction optical element is set so that m1 = 1, and m2 = 0.

7. (withdrawn) The optical pickup as set forth in claim 5, wherein the lens is a planoconvex lens with a spherical convex face, and the diffraction grating is formed on a plane face of the planoconvex lens.

8. (withdrawn) The optical pickup as set forth in claim 6, wherein the lens is a planoconcave lens with an aspherical concave face, and the diffraction grating is formed on a plane face of the planoconcave lens.

9. (withdrawn) The optical pickup as set forth in claim 8, wherein the diffraction grating is formed on a side of the objective lens.

10. (withdrawn) The optical pickup as set forth in claim 1, wherein:

when a diffraction order of first diffracted light is m1, a diffraction order of second diffracted light is m2, a pitch of grooved rings is d, and a sign of an angle created when a normal line of the diffracting face of the diffraction grating tilts toward the optical axis is positive,

the diffracting face of the diffraction grating of the diffraction optical element satisfies

$$\sin^{-1}\left(\frac{m_1 \lambda_1}{d}\right) - \sin^{-1}\left(\frac{m_2 \lambda_2}{d}\right) > 0$$

with the diffraction order m1 of +1 for the first diffracted light, and with the diffraction order m2 of 0 for the second diffracted light.

11. (withdrawn) The optical pickup as set forth in claim 10, wherein the diffracting face of the diffraction grating of the diffraction optical element has such a diffraction characteristic that the first and second light beams are diffracted toward the optical axis.

12. (withdrawn) The optical pickup as set forth in claim 10, wherein the diffraction optical element has the diffracting face on an incident side of the first and second light beams, and has a concave face on an emergent side of the first and second diffracted light, the diffracting face and the concave face having a common optical axis.

13. (withdrawn) The optical pickup as set forth in claim 12, wherein the concave face is aspherical.

14. (cancelled)

15. (cancelled)

16. (withdrawn) An optical pickup for recording or reproducing information with respect to (a) a first recording medium having a light transmissive layer of a thickness t1 on an information recording face and (b) a second recording medium having a light transmissive layer of a thickness t2 greater than t1 on an information recording face, the optical pickup recording or reproducing information with respect to the first recording medium by forming a first light spot on the information recording face of the first recording medium by focusing a first light beam of a wavelength $\lambda 1$ on the information recording face, and the optical pick up recording or reproducing information with respect to the second recording medium by forming a second light spot on the information recording face of the second recording medium by focusing a second light beam of a wavelength $\lambda 2$ greater than $\lambda 1$ on the information recording face,

said optical pickup comprising:

a diffraction optical element for diffracting and refracting incident rays of the first and second light beams so as to emit the first and second light beams; and

an objective lens for causing respective diffracted rays of predetermined diffraction orders of the first and second light beams emitted from the diffraction optical element to focus on the respective information recording faces of the first and second recording media so as to form the first and second light spots,

the first light beam and the second light beam being incident on the diffraction optical element as light beams with different degrees of convergence or divergence.

17. (withdrawn) The optical pickup as set forth in claim 16, wherein the diffraction optical element includes a converging diffraction grating and a diverging lens.

18. (withdrawn) The optical pickup as set forth in claim 17, wherein the first light beam is incident on the diffraction optical element as a converging ray, and the second light beam is incident on the diffraction optical element as a diverging ray.

19. (withdrawn) The optical pickup as set forth in claim 16, wherein the objective lens causes a second order diffracted ray of the first light beam emitted from the diffraction optical element and a first order diffracted ray of the second light beam emitted from the diffraction optical element to focus on the respective information recording faces of the first and second recording media so as to form the first and second light spots.

20. (withdrawn) The optical pickup as set forth in claim 16, wherein the objective lens causes a third order diffracted ray of the first light beam emitted from the diffraction optical element and a second order diffracted ray of the second light beam emitted from the diffraction optical element to focus on the respective information recording faces of the first and second recording media so as to form the first and second light spots.

21. (previously presented) An optical pickup for recording or reproducing information with respect to first, second, and third recording media having information recording faces and light transmissive layers, the light transmissive

layers of the first, second, and third recording media being formed on the respective information recording faces and respectively having thicknesses t1, t2, and t3, which are related to one another by $t1 < t2 < t3$, the optical pickup recording or reproducing information by focusing first, second, and third light beams of wavelengths $\lambda 1$, $\lambda 2$, and $\lambda 3$, which are related to one another by $\lambda 1 < \lambda 2 < \lambda 3$, on the respective information recording faces,

said optical pickup comprising:

an objective lens, movable in a substantially orthogonal direction with respect to respective optical axes of the first, second, and third light beams, for tracking the first, second, and third light beams on the respective information recording faces of the first, second, and third recording media; and

a diffraction optical element, provided on an incident side of the first, second, and third light beams and movable with the objective lens, for diffracting and refracting the first, second, and third light beams so as to cause the first, second, and third light beams to be incident on the objective lens as diffracted rays of predetermined diffraction orders,

said diffraction optical element causing the second and third light beams to be incident on the objective lens as diverging rays, and

said diffraction optical element satisfying

$|\Phi inr| < |\Phi outr|$, and $|\Phi inIr| < |\Phi outIr|$

where Φinr and ΦinIr are degrees of convergence and/or divergence of incident rays of the second and third light beams, respectively, on the diffraction optical element, and Φoutr and ΦoutIr are degrees of convergence and/or divergence of incident rays of the second and third light beams, respectively, on the objective lens, and

where the third light beam is incident on the diffraction optical element as a diverging ray.

22. (original) The optical pickup as set forth in claim 21, wherein the diffraction optical element causes the first light beam to be incident on the objective lens as a parallel ray.

23. (original) The optical pickup as set forth in claim 21, wherein the diffraction optical element causes the first, second, and third light beams to be incident on the objective lens as a second order diffracted ray, a first order diffracted ray, and a first order diffracted ray, respectively,

the diffraction optical element having highest diffraction efficiency for the second order diffracted ray of the first light beam, for the first order diffracted ray of the second light beam, and for the first order diffracted ray of the third light beam.

24. (original) The optical pickup as set forth in claim 23, wherein the diffraction optical element has diffraction efficiency of 90% or greater for the second order diffracted ray of the first light beam.

25. (cancelled)

26. (original) The optical pickup as set forth in claim 25, wherein the first and second light beams are incident on the diffraction optical element as a parallel ray and a diverging ray, respectively.

27. (previously presented) The optical pickup as set forth in claim 26, wherein the first, second, and third light beams are incident on the diffraction optical element with degrees of convergence and/or divergence that satisfy

$0 \leq \varphi \times \Phi inb \leq 0.11$

$-0.048 \leq \varphi \times \Phi inr \leq 0.04$

$-0.18 \leq \varphi \times \Phi inIr \leq -0.1$

where φ is an effective diameter of the objective lens for the first light beam and Φinb represents a degree of convergence and/or divergence of the first light beam incident on the diffraction optical element.

28. (previously presented) The optical pickup as set forth in claim 26, wherein the diffraction optical element satisfies

$-0.11 \leq \varphi \times \Phi b \leq 0$

$-0.2 \leq \varphi \times \Phi r \leq -0.002$

$-0.16 \leq \varphi \times \Phi Ir \leq 0.03$

where Φb, Φr, ΦIr are powers of the diffraction optical element for the first, second, and third light beams, respectively and Φ represents an effective diameter of the objective lens for the first light beam.

29. (withdrawn) The optical pickup as set forth in claim 25, wherein the first light beam is incident on the diffraction optical element as a converging ray, and the second light beam is incident on the diffraction optical element as a converging, parallel, or diverging ray.

30. (withdrawn) The optical pickup as set forth in claim 29, wherein the first, second, and third light beams are incident on the diffraction optical element with degrees of convergence and/or divergence that satisfy

$0 \leq \varphi \times \Phi inb \leq 0.11$

$-0.048 \leq \varphi \times \Phi inr \leq 0.04$

$-0.18 \leq \varphi \times \Phi inIr \leq -0.1$

where$\varphi$is an effective diameter of the objective lens for the first light beam.

31. (withdrawn) The optical pickup as set forth in claim 29, wherein the diffraction optical element satisfies

$-0.11 \leq \varphi \times \Phi b \leq 0$

$-0.2 \leq \varphi \times \Phi r \leq -0.002$

$-0.16 \leq \varphi \times \Phi Ir \leq 0.03$

where Φb, Φr, ΦIr are powers of the diffraction optical element for the first, second, and third light beams, respectively.

32. (original) The optical pickup as set forth in claim 23, wherein the diffraction optical element includes a diverging diffracting face and a concave refracting face.

33. (original) The optical pickup as set forth in claim 23, wherein the diffraction optical element has a spherical refracting face.

34. (original) The optical pickup as set forth in claim 23, wherein the diffraction optical element has a refracting face whose power is not less than –0.1 for the first light beam.

35. (withdrawn) An optical pickup including first, second, and third light sources for respectively emitting first, second, and third light beams of wavelengths $\lambda 1$, $\lambda 2$, and $\lambda 3$, which are related to one another by $\lambda 1 < \lambda 2 < \lambda 3$, the optical pickup recording or reproducing information with respect to first, second, and third recording media respectively having light transmissive layers of different thicknesses, by focusing the first, second, and third light beams on respective information recording faces of the first, second, and third recording media using common focusing means,

said optical pickup comprising:

a diffraction optical element, provided in a common optical path between the first, second, and third light sources and an objective lens and including a diffracting face and a refracting face, for causing the first, second, and third light beams to diverge or converge according to the wavelengths of the first, second, and third light beams, and causing the first, second, and third light beams to diffract on the diffracting face so that the first light beam is incident on the focusing means as a first order diffracted ray and the second and third light beams are incident on the focusing means as first or lower order diffracted rays,

the diffracting face of the diffraction optical element having a diffraction grating whose depth is set so that diffraction efficiency for one diffraction order is higher than that for other diffraction orders with respect to a diffracted ray of each of the first, second, and third light beams incident on the focusing means.

36. (withdrawn) The optical pickup as set forth in claim 35, wherein:

the diffraction optical element causes the first light beam to be incident on the focusing means as a first order diffracted ray, and causes the second and third light beams to be incident on the focusing means as a zeroth order diffracted ray, and

the depth of the diffraction grating on the diffracting face of the diffraction optical element is set so that the diffraction optical element has highest diffraction efficiency for a first order diffracted ray for the first light beam, and a zeroth order diffracted ray for the second and third light beams.

37. (withdrawn) The optical pickup as set forth in claim 36, wherein the diffracting face and the refracting face of the diffraction optical element are a converging diffracting face and a concave refracting face, respectively.

38. (withdrawn) The optical pickup as set forth in claim 35, wherein the depth of the diffraction grating on the diffracting face of the diffraction optical element is set so that the diffraction optical element has 90% or greater diffraction efficiency for a first order diffracted ray for the first light beam.

39. (withdrawn) The optical pickup as set forth in claim 35, wherein the diffraction optical element satisfies

$|\Phi outr| > |\Phi inr|$, and $|\Phi outIr| > |\Phi inIr|$

where Φinr and $\Phi inIr$ are degrees of convergence and/or divergence of incident rays of the second and third light beams, respectively, on the diffraction optical element, and $\Phi outr$ and $\Phi outIr$ are degrees of convergence and/or divergence of incident rays of the second and third light beams, respectively, on the focusing means.

40. (withdrawn) The optical pickup as set forth in claim 35, wherein:

the diffraction optical element causes the first, second, and third light beams to be incident on the focusing means as first order diffracted rays, and

the depth of the diffraction grating on the diffracting face of the diffraction optical element is set so that the diffraction optical element has highest diffraction efficiency for a first order diffracted ray for all of the first, second, and third light beams.

41. (withdrawn) The optical pickup as set forth in claim 40, wherein the diffracting face and the refracting face of the diffraction optical element are a diverging diffracting face and a convex refracting face.

42. (withdrawn) The optical pickup as set forth in claim 35, wherein the refracting face of the diffraction optical element is aspherical.

43. (withdrawn) An optical pickup for focusing first, second, and third light beams of wavelengths $\lambda 1$, $\lambda 2$, and $\lambda 3$, which are related to one another by $\lambda 1 < \lambda 2 < \lambda 3$, on information recording faces of first, second, and third recording media respectively having light transmissive layers, the light transmissive layers being formed on the information recording faces and respectively having thicknesses t1, t2, and t3, which are related to one another by $t1 = t2 < t3$,

said optical pickup comprising:

an objective lens for respectively focusing the first, second, and third light beams on the respective information recording faces of the first, second, and third recording media; and

a diffraction optical element, provided on an incident side of the first, second, and third light beams and provided as an integral unit with the objective lens, for diffracting and refracting the first, second, and third light beams so as to cause the first, second, and third light beams to be incident on the objective lens as diffracted rays of predetermined diffraction orders,

the diffraction optical element causing the third light beam to be focused on the objective lens as a diverging ray, and

the diffraction optical element satisfying

$|\Phi in3| < |\Phi out3|$

where $\Phi in3$ is a degree of convergence or divergence of an incident ray of the third light beam on the diffraction optical element, and $\Phi out3$ is a degree of divergence of an incident ray of the third light beam on the objective lens.

44. (withdrawn) The optical pickup as set forth in claim 43, wherein the diffraction optical element causes the first light beam to be incident on the objective lens as a parallel ray.

45. (withdrawn) The optical pickup as set forth in claim 43, wherein the first light beam is incident on the diffraction optical element as a parallel ray or a converging ray.

46. (withdrawn) The optical pickup as set forth in claim 43, wherein the wavelength $\lambda 1$ of the first light beam is 400nm to 410nm, the wavelength $\lambda 2$ of

the second light beam is 630nm to 660nm, and the wavelength $\lambda 3$ of the third light beam is 740nm to 820nm, and the diffraction optical element causes the first light beam to be incident on the objective lens as a second order diffracted ray, and causes the second and third light beams to be incident on the objective lens as first order diffracted rays,

the diffraction optical element having a higher diffraction efficiency for the second order diffracted ray of the first light beam than for diffracted rays of any other diffraction orders of the first light beam, the diffraction optical element having a higher diffraction efficiency for the first order diffracted ray of the second light beam than for diffracted rays of any other diffraction orders of the second light beam, and the diffraction optical element having a higher diffraction efficiency for the first order diffracted ray of the third light beam than for diffracted rays of any other diffraction orders of the third light beam.

47. (withdrawn) The optical pickup as set forth in claim 46, wherein the diffraction optical element has a 90% or greater diffraction efficiency for the second order diffracted ray of the first light beam.

48. (withdrawn) The optical pickup as set forth in claim 43, wherein the diffraction optical element includes a converging diffracting face and a concave refracting face.

49. (withdrawn) The optical pickup as set forth in claim 1, wherein the diffracting face of the diffraction optical element is formed on a refracting face.

50. (withdrawn) The optical pickup as set forth in claim 1, wherein the diffracting face of the diffraction optical element includes a diffraction grating that is serrated or stepped.

51. (withdrawn) An optical recording and reproducing apparatus comprising an optical pickup that includes:

a first light source that emits a first light beam of a first wavelength $\lambda 1$;

a second light source that emits a second light beam of a second wavelength $\lambda 2$ longer than the first wavelength $\lambda 1$;

an objective lens that focuses the first light beam on an information recording face of a first recording medium having a first light transmissive layer, and focuses the second light beam on an information recording face of a second recording medium having a second light transmissive layer thicker than the first light transmissive layer;

a diffraction optical element disposed in an optical path between the first and second light sources and the objective lens, and including a diffraction grating and a lens with a refractive index n; and

a collimator lens, provided between the first light source and the diffraction optical element and between the second light source and the diffraction optical element, for causing the respective first and second light beams of the first and second light sources to be incident on the diffraction optical element as parallel rays,

wherein:

when a distance between a diffracting face of the diffraction grating and a peak of a lens face of the lens is a, a radius of the second light beam is R, and a pitch of the diffraction grating confined by outermost rays of the second light beam passing through the diffracting grating is d,

said diffraction optical element is set so that m1 and m2, which are diffraction orders of the first and second light beams, respectively, satisfy

$$f(\mathrm{d}, m_1) = f(\mathrm{d}, m_2),$$

where f(d, m_x), x being 1 or 2, is a function given by

$$f(d, m_X) = \frac{(R - a\tan\alpha_X)\sqrt{C_X{}^2 + S_X{}^2}}{S_X - C_X \tan\alpha_X - \sqrt{C_X{}^2 - S_X{}^2}\tan\alpha_X}$$

$$C_X = n\cos\alpha_X - \cos\beta_X$$

$$S_X = n\sin\alpha_X - \sin\beta_X$$

$$\sin\alpha_X = \frac{m_X \lambda_X}{d},$$

where α1 is an diffraction angle for m1-th order diffracted light for the first light beam through the diffraction grating, β1 is an angle made by a refracted ray of the m1-th order diffracted light through the lens with respect to an optical axis of the first light beam, α2 is an diffraction angle for m2-th order diffracted light for the second light beam through the diffraction grating, β2 is an angle made by a refracted ray of the m2-th order diffracted light through the lens with respect to the optical axis.